UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

UNITED STATES OF AMERICA	)	
	)	No. 18 CR 278
v.	)	
	)	Judge Harry T. Leinenweber
ERNESTO GODINEZ	)	
	)	

**GOVERNMENT'S RESPONSE TO DEFENDANT'S
MOTION IN LIMINE TO BAR SHOTSPOTTER EVIDENCE**

Defendant's motion should be denied because ShotSpotter evidence is based on decades old mathematical principles that will assist the jury in understanding from approximately what location the sound of gunshots originated on May 4, 2018. Furthermore, Paul Greene, the government's expert, is qualified to offer this type of evidence to the jury based on his training and experience in this field.

BACKGROUND

On June 6, 2018, the government disclosed to the defense the ShotSpotter forensic report and four audio files collected by ShotSpotter sensors. On April 18, 2019, the government provided the defense with the ShotSpotter forensic report authored by Paul Greene (Exh. A), and the audio files collected by ShotSpotter sensors. [1] On May 6, 2019, the government provided notice to the defense of its intention to call Mr. Greene as an expert witness (Exh. B), along with his Curriculum Vitae (Exh. C).

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[1] The report disclosed on June 6, 2018 did not differ materially from the report disclosed on April 18, 2019. The audio files disclosed on April 18, 2019 are identical to the ShotSpotter audio files disclosed to the defense on June 6, 2018.

The government expects that Mr. Greene will testify that ShotSpotter has three primary components: acoustic sensors, a location server application, and a Flex user interface application. Ex. A. at 3. The location server is hosted on a virtual server, the user interface is housed on the customer's computer or mobile device, and the sensors, which detect acoustic impulses or sounds, are located in specific locations determined by the customer.

Impulsive sounds trigger the Shotspotter sensor. The sensor then transmits the acoustic measurements of the sound and the exact time that they were detected to the location server. The location server analyzes the data transmitted by the acoustic sensor and determines if the sound can be geographically located and classified as a gunshot incident. Id. If the sound can be located and classified as gunfire, location server reports the incident to a ShotSpotter review center where a Shotspotter employee manually reviews the incident to determine the accuracy of the classification of the sound as a gunshot. ShotSpotter employees, such as Mr. Greene, can also evaluate data from an acoustic server using software that uses the same principles as the location server. Ex. A. at 7.

Shotspotter determines the location of a sound, or an acoustic pulse, using the mathematical principle of multilateration. As set forth in Mr. Greene's report:

> Multilateration requires a minimum of three sensors that surround the source to accurately report the time that a pulse is detected. Each participating sensor will detect the same pulse at slightly different times. The Location Server calculates the time differences of detected pulses between unique pairs of sensors against the speed of sound (343 meters per second, or 768 mph) to generate a curve called a hyperbola. All the resulting hyperbolae are then plotted onto a map. The spot where the hyperbolae intersect is where ShotSpotter locates the shot. When

more than three sensors participate in the detection, Location Server performs automatic calculations to find a solution that minimizes the error to the greatest extent possible.

Ex. A at 8. The pictorial representation of the hyperbolae calculated by the ShotSpotter for two of the gunshots on May 4, 2018 is depicted in Mr. Greene's forensic report. Id. Mr. Greene's report also includes the visual depiction of the audio waveforms for seven gunshots captured by Sensors 3160, 3154, and 3153.

The government expects that Mr. Greene will testify that the ShotSpotter system detected two gunshots discharged at 3:18:14 and 3:18:15 a.m. on May 4, 2018 and calculated the location of the shots to be near 1720 W. 44th Street. At the request of the Chicago Police Department, ShotSpotter customer service searched the audio files of sensors near 1720 W. 44th Street and found the audio files of five additional gunshots on four sensors. Those audio files were then downloaded. Mr. Greene is expected to testify that he then analyzed the audio files of the five shots initially undetected by the location server, examined the audio waveform (as is depicted in Exhibit A) from each file, and determined the time of discharge of each of the five shots to be between 3:18:10 a.m. and 3:18:12 a.m. Using the ShotSpotter software, which relies upon the theory of multilateration and the time difference of arrival of the sound of each of the gunshots at the sensor, Mr. Greene identified the latitude and longitude of the five shots and located the first five shots to 4338 S. Hermitage Avenue.

ShotSpotter is one of many entities which has used gunshot acoustic location technology for law enforcement, military, or other public safety purposes.[2] Gunshot location technology first was attempted in the mid-1970s, but it was in 1992, when researchers at the United States Geological Survey, using acoustic sensors and seismic technology (often used in the study of earthquakes), developed the early version of gunshot location detection systems. Exh. D at 1 (Aguilar, P., "Gunshot Location Systems," Oct. 11, 2013, 47th International Carnahan Conference on Security Technology.) The first modern gunshot location system was employed in 1996 in Atlanta during the Olympic Games. Id. Shotspotter is one of a number of a systems that localizes gunshots using acoustic sounds; similar systems include Boomerang, which is used by the military identify the location of snipers, the SECURES system, and Pilar. *See, e.g.,* Exh. E at 1 (Damarla, T., "Azimuth & Elevation Estimation using Acoustic Array," July 29, 2010, 13th International Conference on Information Fusion); Exh. F at 1 (Louzri, H., et al., "Impulsive acoustic source localization via wireless sensor Imote2," Dec. 13, 2015, 4th International Conference on Electrical Engineering); Exh. G at 1 (Jurca, L., "Considerations on Acoustic Source Localization," Dec. 14, 2007, 6th WSEAS International Conference of Computational Intelligence.)

The ShotSpotter system itself was evaluated by the National Law Enforcement and Corrections Technology Center (NLECTC) in a study in 2006, which found that the detection system accurately detected and located shots in the coverage area

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[2] https://www.cnbc.com/2017/10/10/gunfire-detection-systems-see-renewed-interest-after-las-vegas-tragedy.html

between 82-99%. Exh. H at 4. In 2002, researchers working with the University of

Cincinnati and the National Institute of Justice also tested the ShotSpotter system,

and found that, during field tests, the system "was able to triangulate (locate)

gunshots at 84 percent of the event locations within a margin of error of 41 feet." Exh.

I at 19.

ARGUMENT

The admissibility of expert testimony is governed by Federal Rule of Evidence

702 and the framework established by the Supreme Court in *Daubert v. Merrell Dow*

Pharmaceuticals, Inc., 509 U.S. 579 (1993). Specifically, expert testimony is

admissible at trial pursuant to Federal Rule of Evidence 702 as set forth below:

> If scientific, technical, or other specialized knowledge will assist the trier
> of fact to understand the evidence or to determine a fact in issue, a
> witness qualified as an expert by knowledge, skill experience, training,
> or education may testify thereto in the form of an opinion or otherwise,
> if (1) the testimony is based upon sufficient facts or data, (2) the
> testimony is the product of reliable principles and methods, and (3) the
> witness has applied the principles and methods reliably to the facts of
> the case.

Fed.R.Evid. 702.

This Court is well aware of the non-exhaustive list of factors established in

Daubert to determine whether the requirements of Rule 702 are met, which include:

(1) whether the expert's technique or theory is testable or has been tested; (2) whether

the technique or theory has been subject to peer review and publication; (3) the known

or potential rate of error in applying the technique or theory; (4) whether standards

and controls exist and were maintained; and (5) whether the technique or theory is

generally accepted in the scientific community. *Id.* at 593-94. Expert testimony, like

all other admissible evidence, is subject to testing by "[v]igorous cross examination, presentation of contrary evidence, and careful instruction on the burden of proof." Id. at 596.

The Court's gatekeeping function applies to all expert testimony and not just scientific expert testimony. *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 147-49 (1999). *Kumho Tire* also made it clear that a trial court is not required to conduct a pretrial hearing based on a Daubert challenge. *Id.* at 152. A trial court has considerable latitude in deciding whether or when special briefing or other proceedings are needed to investigate challenged reliability of proposed expert testimony. *Id.* at 152-53. Pretrial evidentiary hearings are particularly unnecessary when expert testimony is based on well-established principles.

As Mr. Greene's report, and the third-party publications reviewing the use of multilateration/triangulation in gunshot detection technology demonstrate, his opinions are the product of reliable principles and methods and are generally accepted within his field.

I.   Paul Greene's Qualifications

Mr. Greene has been qualified and testified as an expert witness on the Shotspotter system in state and federal courts on more than 80 occasions. Exh. C. Mr. Greene has employed by Shotspotter for 12 years, and during that time, has listened to, and analyzed, audio recordings of thousands of gunshot incidents and prepared the forensic analyses of over 1000 shooting incidents.

The Nebraska Supreme Court has specifically addressed the validity of Mr. Greene's expert testimony and evidence regarding the location of ShotSpotter

detected gunshots. *State v. Hill,* 288 Neb. 767, 792 (Neb. 2014) (admission of Greene's testimony and ShotSpotter report was proper.) The court in *Hill* described ShotSpotter as a system which "uses microphones and a global positioning system (GPS) to pinpoint the time and location of sounds consistent with gunshots in the area covered by the system," *Id.* at 770. The trial court found that the ShotSpotter system used "triangulation to pinpoint the latitude and longitude of the sound and a process called 'geolocation' to place that location on a map." *Id.* at 775. Based on testimony at a pretrial *Daubert* hearing and at trial, the trial court in *Hill* qualified Mr. Greene as "an expert in the design, installation, and function of the ShotSpotter system and in gunshot sound recognition," and found "the ShotSpotter system was sufficiently reliable." *Id.* at 778. The Nebraska Supreme Court agreed,[3] and held the ShotSpotter system to be reliable, and Greene's testimony to have been properly admitted. *Id.* at 794. This Court should find the same.

II. Gunshot Location Detection is Scientifically Valid, Probative, Reliable and Relevant

One of the foundations of the ShotSpotter's gunshot location detection system is the mathematical principle of multilateration, which is similar to the more commonly used term of triangulation. ShotSpotter employs multilateration in its location server and software to generate the hyperbola described in Mr. Greene's report (Exh. A), which is based on the time difference in the arrival of the sound of

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[3] The Nebraska Supreme Court also noted the defendant's argument to be "somewhat dubious" given that "the victim was confirmed shot in almost the exact location identified by the ShotSpotter". *Hill,* 288 Neb. at 793. In the instant matter, the ShotSpotter computerized location server detected two gunshots at 1720 W. 44th Street at 3:18 a.m. and the government expects that Chicago Police Department Officer Thomas Spratte will testify that he fired two shots from that location at approximately that time.

the gunshot at each sensor. As the *Hill* court noted, Mr. Greene testified that the mathematical principles used by ShotSpotter has been recognized for decades, at least since World War I, and has been used to detect earthquakes and by the Navy and in space. *Hill,* 288 Neb. at 775-76.

Indeed, the determination of a cellphone's location using cell-site location information is fundamentally based on the use of the theory of multilateration. *United States v. Powell*, 943 F. Supp. 2d 759, 767 (E.D. Mich. 2013), ("This fact, combined with the fact that in a typical urban environment, a cell phone will be in range of and submit information to several cell towers simultaneously, makes it possible to calculate a cell phone's location within anywhere from several blocks to a few feet using the mathematical process of "multilateration.") The Supreme Court in the recent decision regarding historical cell-site location information described the ability of new technology to pinpoint location based on triangulation[4] methods. *Carpenter v. United States*, 138 S. Ct. 2206, 2219 (2018). Of course, the Seventh Circuit has recognized historical cell-site analysis to be admissible under *Daubert*. *United States v. Lewisby*, 843 F.3d 653, 659-60 (7th Cir. 2016) (""[u]sing call records and cell towers to determine the general location of a phone at specific times is a well-accepted, reliable methodology.") The mathematical principles underlying historical cell-site analysis and the Shotspotter technology are the same, and should be treated similarly for the purpose of determining evidentiary value.

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[4] Triangulation is the application of the mathematical concept when there are precisely three reference points, but when the process may involve more or fewer than three reference points, "multilateration" is a more accurate term. *Powell*, 943 F. Supp. 2d at 767 n. 2.

Defendant objects to Mr. Greene's testimony and the ShotSpotter evidence claiming that they are "not the product of reliable principles and methods that have been tested and approved by standards in the scientific community." Doc. No. 58 at 2. Contrary to the defendant's claim, the evidence that the government intends to offer is scientifically valid, probative, and reliable. As set forth above, the basic technology used by Shotspotter has been used by various systems, created by different companies, for decades. The underlying mathematical principles of multilateration and triangulation have existed even longer.

If called to testify as an expert, the government expects Mr. Greene would testify about the process by which ShotSpotter collects audio data, and analyzes that data to determine if a sound is a gunshot and where that gunshot was located. He would testify that he was provided the audio waveform files from four ShotSpotter sensors relevant to this case and that he reviewed these audio files. He would testify that based on his analysis, he was able to identify five gunshots not detected by the ShotSpotter location server, determine the time of discharge for the five gunshots, and the location of the gunshots to within a circle with a radius of 25 meters.

In challenging Mr. Greene's proposed testimony and the Shotspotter evidence, the defendant also argues that it has not received the raw data collected by ShotSpotter, and it must have details regarding "the number, accuracy, reliability, and proper calibration" of ShotSpotter sensors. Doc. No. 58 at 3. The defendant has received the so-called raw data – Mr. Greene will testify that he used the audio files

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– disclosed to the defendant in June 2018 – in the ShotSpotter software to determine the time of discharge and the location of the gunshots.

The details of the upkeep and accuracy of the sensors are matters that can be raised on cross-examination, and this is not a reason to exclude Mr. Greene's testimony. To the extent that defendant disagrees with Mr. Greene's ultimate conclusions, he is free to challenge them and their underlying factual support and scientific bases. The defendant will have ample opportunity to cross-examine the expert. Further, the factors such as the functioning and reliability of the sensors do not go to the admissibility of the ShotSpotter evidence, but to the weight of the evidence.

The gunshot detection evidence is admissible at trial when introduced through a qualified expert witness pursuant to Rule 702, *Daubert*, and *Kumho Tire*. It is based on valid, reliable, scientific principles that will assist the jury in understanding the government's evidence regarding the location of the seven gunshots fired on May 4, 2018 at 3:18 a.m. Paul Greene is qualified to offer this type of evidence to the jury based on his training, experience, and education in this specialized field. Indeed, the government has not found a single case in which Shotspotter evidence was found to inadmissible. The government therefore respectfully requests, pursuant to *Kumho Tire*, that the Court deny the defense's request for a *Daubert* hearing regarding Mr. Greene. 526 U.S. at 152.

Finally, the defendant also moves to exclude evidence of the location of the discharge of the gunshots because they are unduly prejudice under Fed.R.Evid. 403.

The defendant offers no argument as to how the evidence is unduly prejudicial. "[M]ost relevant evidence is, by its very nature, prejudicial, and that evidence must be *unfairly* prejudicial to be excluded." *United States v. Pulido,* 69 F.3d 192, 201 (7th Cir. 1995). Mr. Greene's expected testimony and the ShotSpotter evidence is not unduly prejudicial, and should not be excluded.

CONCLUSION

For the foregoing reasons, the government respectfully requests that this Court deny the defendant's motion in limine to exclude the ShotSpotter evidence and the expert testimony of Paul Greene, and deny the defendant's request for a *Daubert* hearing.

Dated: May 20, 2019

Respectfully submitted,

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